NATIONAL ACCELERATOR LABORATORY

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Trip to Oak Ridge National Laboratory on January 11, 1968

M. Awschalom

The day was spent talking with Drs. R. G. Alsmiller, F. S. Alsmiller, and H. Bertini as well as Messrs. W. Armstrong and J. Babish.

In the morning, there was a presentation of some of the many problems we have at NAL and for which we would like to have calculations. The problems mentioned were:

(a) shielding of the 200 MeV linac,

(b) large penetrations (personnel) through this shield,

(c) shielding of the 10 and 200 GeV synchrotrons and penetrations through these shields,

(d) control of the remanent radiation fields in the synchrotron tunnels using thick absorbers next and around hot spots,

(e) shielding of the beam stops and collimators,

(f) muon shield calculations.

In the afternoon item (d) was discussed in detail -

Two points were made clear from the onset of the conversations: (1) they are short of manpower and (2) there is no model to predict low energy hadron production by high energy protons. Trilling's (or C.K.P.'s or RANFT's) formula cannot be trusted below a couple of hundred MeV. Hence, some model must be developed to extend particle production to these low energies. I suggested the following approach: take the 3 GeV model which gives fairly good predictions all the way down and fold-in the sharper forward cone of the higher energy proton induced reactions. Then, if the folding-in is successful, the new formula should still reproduce the 3 GeV results and Trilling's results at high energies.

Shielding of 200 MeV Linac

Dr. R. G. Alsmiller thinks well of O'Brien's multigroup calculations. His own Monte Carlo calculations are in good agreement with O'Brien's. Alsmiller will repeat O'Brien's calculations at 200 MeV. He suggests adding an extra safety factor of 2 and use K. O. B. 's results.

Laberynths through the 200 MeV Linac Shielding

ORNL's reactor group is not well equipped to handle such a hard neutron source. They cannot do anything to help us in time.

Dr. Bertini commented that in reactor calculations it was found that the major contribution to the neutron dose coming out from a penetration was that transmitted through the weakened shield. The neutrons "leaking" along the laberynth contributed little to the total dose.

Shielding of the 10 and 200 GeV synchrotrons

They cannot help us yet. The idea of calculating the shield to attenuate a lateral dose proportional to the beam power lost was considered proper. Then, one is to use BNL and CERN surface dose measurements and extrapolate to larger shield thicknesses with a reasonable relaxation length.

Control of Remanent Radiation Fields

They were most interested in this problem because it is similar to one they are now working on: the radioactivation of the moon surface. They propose to handle the problem using the following geometry. Hadron source: 200 GeV protons lost along an infinite line centered in a solid iron cylinder (magnet). This cylinder will be followed by cylindrical shells: (1) six-inch heavy concrete, (2) iron, (3) about six-inch boron-loaded concrete, (4) air (tunnel), and (5) concrete (wall). The purpose of the heavy concrete of shell No. 1 is to provide a paramagnetic space between the magnets and the bulk of the Fe shield. Shell No. 3 will be studied in conjunction with wall activation. Boron loading of the wall concrete will also be studied.

Low energy hadron source from high energy protons: my proposal or something similar. Calculation procedure: (1) get all isotopes per unit volume as a function of radius; (2) use a gamma transport code to get exposure dose rate at a point 5 feet from axis of cylinder.

Expected completion date: not earlier than July - August, 1968.

Shielding of Beam Stops and Collimators

This problem is analogous to the previous one except that now we will have a point source. They are interested in doing this problem, but they cannot talk "delivery dates" until the previous one is finished.

Muon Calculations

All calculations made so far by Alsmiller neglect bremstrahlung and pair production. R. G. Alsmiller's calculations include multiple Coulomb scattering of pions and muons and they show a wider angular spread than D. Keefe's. R. G. Alsmiller hopes to meet with D. Keefe to try to resolve this difference.

R. G. Alsmiller has compared the muon shields predicted by his Monte Carlo method and the analytic form proposed by Eyges. The two seem to give essentially similar results. However, the Monte Carlo calculation requires about 10 hours computer time versus about one-half hour for the Eyges' method.

As soon as the Alsmiller-Keefe difference is understood, R. G. Alsmiller will send me the results of his calculations, and he will be glad to tackle any other geometry and material using Eyges' formula. His present results are for iron shields.

Other Topics

In addition to the subjects listed above, R. G. Alsmiller and I discussed a possible manner to optimize the usefulness of the Radiation Physics Group at NAL. The proposed idea was to form a group to review the state of the art of high energy shielding and nuclear reaction calculations. This group would meet periodically. Similar meeting would take place for dosimetric problems with a somewhat different group of people.

Since most of the people interested in these subjects will be present at the ANS meeting in Toronto, the first meeting will take place there. The proposed list of participants is:

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| ORNL | - | R. G. Alsmiller |
| LRL | - | R. Wallace and D. Keefe |
| SLAC | - | Ralph Nelson |
| Los Alamos | - | D. Cochran |
| HASL | - | K. O'Brien and J. McLaughlin |
| BNL | - | G. Levine |
| CERN-RHEL | - | J. Ranft |